TITLE OF THE INVENTION

MOBILE RADIO APPARATUS AND CONTROL DEVICE THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the

5   benefit of priority from the prior Japanese Patent

Application No. 2000-200237, filed June 30, 2000, the

entire contents of which are incorporated herein by

reference.

BACKGROUND OF THE INVENTION

10   1.   Field of the Invention

The present invention relates to a mobile radio

apparatus and its control device.

2.   Description of the Related Art

FIG. 8 is a view showing a frame format in

15   a conventional W-CDMA system.   FIG. 9 is a view showing

a flow of synchronization acquisition processing

defined in accordance with a conventional standard

specification, for example.

In the W-CDMA system, as shown in FIG. 8, one

20   frame consists of 10 ms, wherein its contents are

divided into 15 slots (slot numbers #0 to #14).

Synchronization acquisition processing first

detects a primary search code (hereinafter, referred to

as P-SCH) inserted into each slot by a matched filter,

25   and identifies a slot timing (step S100).   Next, as in

the P-SCH, a pattern of a secondary search code (S-SCH)

inserted into each slot is checked, and a group of

codes to be searched and a frame timing are identified.
Here, in the S-SCH, a pattern for each frame is
acquired for each slot in order to indicate patterns 1
to 17, and is collated with a table held by a receiver,

5 whereby the group and frame head can be detected.

For example, in the case where an S-SCH pattern
for each slot has been detected as 5, 16, 7, 3, 14, 16,
3, 10, 5, 12, 14, 12, 10, 1, and 1 relevant to a
temporarily set frame, a list of these numbers

10 corresponds to group 2, and thus, the group numbers can
be specified. Sequentially, the essential patterns of
group 2 are 1, 1, 5, 16, 7, 3, 14, 16, 3, 10, 5, 12,
14, 12, and 10 sequentially in order from the frame
head of a system so that the 14th slot of the detected

15 patterns can be specified as the head of the essential
system frame. If these patterns are judged by
hardware, there is a high possibility that a search
fails due to a bit error or the like. Thus, in
general, receiving power is measured for all the

20 patterns by way of hardware judgment, and a group is
specified by comparing them with each other. In this
system, there are 64 groups, thus making it necessary
to search all the 64 patterns if these patterns are
searched as they are.

25 That is, as shown in the steps S101 to S103, a
total of 15 S-SCH powers is obtained for each of groups
#1 to #64. Then, at the step S104, the power values of

groups #1 to #64 are compared with each other, a maximum value is defined as a currently searched group, and at the same time, a frame timing is also specified.

When the timing and group of the frame head have been specified, all scramble codes (here, defined as #1 to #8) that belong to this group are demodulated in accordance with a specified frame timing, and power is judged (steps S105 to S107). Then, the power values of the scramble codes #1 to #8 are compared with each other, whereby it is specified as to which of the scramble codes are used for transmission at a transmission side (step S108).

When the above processing has been completed, the system synchronization acquisition completes (step S109), which enables communication.

However, in the above described conventional method, in the case of performing synchronization acquisition processing immediately after power has been turned ON or after out-of-synchronization has been established, it is required to perform identical processing 64 times in order to identify a group. In addition, in order to identify a scramble code after the group has been identified as well, all the codes that belong to the group are used to cause operation, and these codes are compared with each other, thereby making it necessary to determine a code.

Therefore, there is a problem that an amount of

synchronization acquisition processing increases, much
processing time is required, and current consumption
increases.

BRIEF SUMMARY OF THE INVENTION

5   The present invention has been made in view of
the foregoing problem. It is an object of the present
invention to provide a mobile radio apparatus and
its control device capable of reducing an amount of
synchronization acquisition processing and reducing
10   a processing time and current consumption.

To attain the aforementioned object, a mobile
radio apparatus according to a first aspect of the
present invention, which selectively transmits one or
some of candidates of a plurality of spread codes and
15   selects one or more candidates of the transmitted
spread codes among a databse of spread code and
performs synchronization with the transmitted spread
codes, the mobile radio apparatus comprising: receiver
configured to rearrange a group data of spread code
20   based on frequency of the spread code and generate
a database of spread codes based on the rearranged
group data.

To attain the aforementioned object, a control
device of a mobile radio apparatus according to
25   a second aspect of the present invention, which
selectively transmits one or some of candidates of
a plurality of spread codes and selects one or more

candidates of the transmitted spread codes among a
database of spread code and performs synchronization
with the transmitted spread codes, the control device
comprising; control section configured to rearrange

5   a group data of spread code based on frequency of the
spread code and generate a database of spread codes
based on the rearranged group data.

Additional objects and advantages of the invention
will be set forth in the description which follows, and

10   in part will be obvious from the description, or may
be learned by practice of the invention. The objects
and advantages of the invention may be realized and
obtained by means of the instrumentalities and
combinations particularly pointed out hereinafter.

15   BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated
in and constitute a part of the specification,
illustrate presently embodiments of the invention, and
together with the general description given above and

20   the detailed description of the embodiments given below,
serve to explain the principles of the invention.

FIG. 1 is a view showing a configuration of
a mobile radio apparatus to which the present invention
is applied;

25   FIG. 2 is a flow chart illustrating the details
of synchronization acquisition processing according to
a first embodiment of the present invention;

FIG. 3 is a flow chart illustrating the details of synchronization acquisition processing according to a second embodiment of the present invention;

FIG. 4 is a flow chart illustrating the details of synchronization acquisition processing according to a third embodiment of the present invention;

FIG. 5 is a view showing a database table configured in the first embodiment of the present invention;

FIG. 6 is a view showing a database table configured in the second embodiment of the present invention;

FIG. 7 is a view showing a database table configured in the third embodiment of the present invention;

FIG. 8 is a view showing a frame format in a conventional W-CDMA system; and

FIG. 9 is a view showing a flow of conventional synchronization acquisition processing.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings. FIG. 1 is a view showing a configuration of a mobile radio apparatus to which the present invention is applied. In the figure, a radio signal transmitted from a base station (not shown) is inputted to a receiver circuit (RX) 3 via an antenna

shared device 2 (DUP) after received by an antenna 1.
At the receiver circuit 3, the above radio frequency
signal is mixed with a receiving local oscillation
signal outputted from a frequency synthesizer (SYN) 4,
5   and the mixed signals are frequency converted into
an intermediate frequency signal. A frequency of the
receiving local oscillation signal generated from the
above frequency synthesizer 4 is indicated by a control
signal SYC from a control section 12 composed of a CPU.
10   The above receiving intermediate frequency signal
is subject to quadrature demodulation processing at a
CDMA signal processing section 6, and thus, is despread
by means of a spread code (PN code) assigned to a
receiving channel. In this manner, the despread signal
15   is converted into demodulation data in a predetermined
format according to a data rate. Then, the thus
converted demodulation data is inputted to a voice
encode processing section 7. In addition, of the above
receiving data, the data indicating a data rate is
20   inputted as a receiving data rate to the control
section 12.

        The voice encode processing section 7 applies
expansion processing according to a receiving data
rate notified from the control section 12 to the
25   demodulation data outputted from the above CDMA signal
processing section 6. Then, this section performs
decode processing and error correction processing using

a Viterbi decoding or the like, and reproduces baseband receiving digital data.

A PCM encode processing section 8 performs different signal processing according to type (voice communication or data communication) of digital voice signal communication outputted from the control section 12. That is, during voice communication, this section PCM decodes receiving digital data outputted from the voice encode processing section 7, and outputs an analog receiving signal. This analog receiving signal is loudly outputted by means of a speaker 10 after amplified by means of a receiving amplifier 9. In addition, during data communication, this section outputs to the control section 12 the receiving digital data outputted from the voice encode processing section 7. The control section 12 stores the above receiving digital data in a storage section 13. Here, the storage section 13 is composed of a nonvolatile memory such as EEPPROM. In addition, this storage section outputs the above receiving digital data from an external interface to a hand held information terminal (PDA: Personal Digital Assistants) or a personal computer such as notebook type personal computer.

In contrast, a speaker's transmission voice during voice communication is amplified to a proper level by means of a transmitting amplifier 18 after inputted to a microphone 11. Then, PCM encode processing is

applied to the amplified voice at the PCM encode

processing section 8, and the encoded voice is inputted

as transmission data to the voice encode processing

section 7. In addition, data outputted from a personal

5   computer (not shown) or image data inputted from a

camera (not shown) is inputted to the control section

12 via the external interface, and the inputted data or

image data is outputted to the voice encode processing

section 7 via the PCM encode processing section 8 from

10   the control section 12.

During voice communication, the voice encode

processing section 7 detects an energy quantity of an

input voice from transmission voice data outputted from

the PCM encode processing section 8, and determines

15   a data rate based on the detection result. Then, this

section compresses the above transmission data into

a burst signal in a format according to the above

data rate, further applies error correction/encode

processing to the compressed signal, and outputs it

20   to a CDMA signal processing section 6. In addition,

during data communication, this section compresses

transmission data outputted from the PCM encode

processing section 8 into a burst signal in a format

according to a preset data rate, further applies error

25   correction/encode processing to the compressed signal,

and outputs it to the CDMA signal processing section 6.

Any data rate during voice communication and data

communication is notified as a transmission data rate to the control section 12.

The CDMA signal processing section 6 applies spread processing to the burst signal compressed at the above voice encode processing section 7 by using a PN code assigned to a transmission channel. Then, this section performs quadrature modulation processing for the spread encoded transmission signal, and outputs this quadrature modulated signal to a transmitter circuit (TX) 5.

The transmitter circuit 5 combines the above quadrature modulated signal with a transmission local oscillation signal generated from a frequency synthesizer 4, and converts it into a radio frequency signal. The transmission circuit 5 amplifies only an effective portion of the above radio frequency signal based on the transmission data rate notified by the control section 12. A transmission radio frequency signal outputted from this transmitter circuit 5 is supplied to the antenna 1 via the antenna shared device 2, and is burst transmitted from this antenna 1 to a base station (not shown).

Keys such as dial key or call origination key, power key, exit key, volume control key or mode specification key are provided at an input section 14. In addition, at a display section 15, there is provided an LCD display for displaying a telephone number of

a called speaker's terminal or device operation
state and receiving data and the like, or an LED lamp
that represents a charge operation of a battery 16.
Reference numeral 17 denotes a power circuit that
5   generates a predetermined operating power voltage Vcc
based on an output of the battery 16 and supplies the
voltage to each circuit section.

In the meantime, the control section 12 has a
microcomputer as a main control section, for example.
10   This control section provides a function for performing
synchronization acquisition processing according to
the present embodiments described later as well as
a communication control function for establishing
a communication link between the control section and
15   a base station according to call origination, thereby
making data communication, or a control function for
recording/reproducing the voice of the called speaker
by using the storage section 13.

Hereinafter, synchronization acquisition
20   processing according to the present embodiments will be
described. In the case where a mobile radio apparatus
is used at a comparatively identical place, the number
of base stations to be acquired by synchronization
acquisition processing after power has been turned ON
25   is identical to the number of mobile radio apparatuses
at a high probability or is limited. In such a case,
a database having its priority in groups or scramble

codes for performing synchronization acquisition
processing is generated, and some patterns with their
particularly high priority are first searched, thereby
making it possible to remarkably reduce a synchroniza-
tion acquisition processing time in the case where the
database is used at the same place as the base station.
Even in the case where the database has been used
at the other place, conventional synchronization
acquisition processing is performed at a stage at which
a search of data held in the database is completed,
thereby making it possible to cope with all the
patterns.

First, a group during synchronization acquisition
and the related scrambling code used at this time are
held. These items of data are stored as a database
in the above storage section 13, and the stored items
of data are rearranged in order from the frequently
used data. The less frequent data may be erased from
the database. In addition, even in the case where a
group/scramble code used during handoff or the like has
been changed, the database can be updated. The above
database can be configured by a combination of groups
or a combination of groups and scrambling codes.

As a result, a database table as shown in FIG. 5
and FIG. 6 is generated. Alternatively, even if a list
of tables held in a receiver is changed and used
without generating such database table, the same

advantageous effect is achieved.

Hereinafter, synchronization acquisition
processing according to a first embodiment of the
present invention will be described in detail with
reference to FIG. 2. In the present embodiment, table
information contains only group data, and therefore,
a database table is configured as shown in FIG. 5.

Processing for detecting P-SCH inserted into
each slot immediately after starting synchronization
acquisition processing, and identifying a slot timing
is identical to that according to prior art (step S1).
Next, database specification data (group) is checked
at the detected slot timing (steps S2 and S3). Here,
a database updated every time acquisition is performed
and every time a new group is used is used, a group
first prepared at the head of the database, i.e.,
a pattern of group number #3 in this example is used to
identify a frame.

At this time, a S-SCH collation value (power
value) is obtained in a pattern of a specified group
number (step S5). At this time, it is judged whether
or not the collation value is greater than a set
threshold. If it is affirmatively judged, a frame is
assumed as having successfully specified. This
processing is continued until the group/frame has been
successfully specified or data stored in the database
has been checked.

This processing is repeated, and it is judged whether or not processing count (processing count indicating which number of database is to be searched with priority) has reached a preset condition (step S4). In the case of YES, the above processing is stopped, and synchronization acquisition processing according to the prior art is performed for a group/frame other than database (step S5).

In this case, although it is conventional processing, a group targeted for database priority processing has been already checked. Thus, it is judged that detection is unacceptable (NG). Therefore, such group may be excluded from a candidate of spread codes.

A scramble code is specified after the above group has been successfully specified. This processing is identical to that according to the prior art. Scrambling codes that belong to a plurality of groups are assigned to a specified frame timing, power is measured (step S7), and a large amount of power is selected.

Following the step S7 or step S7, processing goes to the step S9 at which a database is updated, and synchronization acquisition processing is completed (step S10).

Now, synchronization acquisition processing according to a second embodiment of the present

invention will be described in detail with reference
to FIG. 3. In the present embodiment, a database table
is configured by a combination of groups and scramble
codes. In this case, the table is configured as shown
5   in FIG. 6.

Processing for detecting P-SCH inserted into each
slot immediately after starting synchronization
acquisition processing, and identifying a slot timing
(step S20) is identical to that according to the
10   previously described first embodiment.

Next, database specification data (group and code)
is checked at the detected slot timing (steps S21 and
S22). Here, a database updated every time acquisition
is performed is used, and a group/code first prepared
15   at the head of the database, i.e., group number #3 and
scramble code number #1 in this example are used to
check whether or not that timing coincides with the
group and code specified by the database at the
detected slot timing.

20   Frame synchronization processing is performed
by using a group pattern, a scramble code is applied
to the thus detected frame, and power is measured.
Although a plurality of codes are detected by comparing
them with each other in a conventional method,
25   comparison processing cannot be performed in the
present embodiment because only one scramble code is
targeted. Thus, when power is measured by applying

a scramble code, it is judged whether or not detection
is acceptable (OK) according to whether or not the
power value is equal to or greater than a set threshold
(step S22). In the case where the detection is OK,

5 processing goes to the step S25 at which the database
is updated, and then, synchronization acquisition
processing is completed (step S26).

In the case where the detection is not OK, a
combination of groups/codes is assumed to be incorrect.

10 Then, the next candidate of spread codes in the
database is used to make a check in the similar
procedures. In this example, processing is performed
to judge whether or not power equal to or greater than
a threshold can be taken by group number #45 or

15 scramble code number #5.

In the case where the above processing is
repeated, and processing count (processing count
indicating which number of database is to be searched
with priority) reaches a preset condition, the judgment

20 result is YES at the step S23. Then, processing goes
to the step S24 at which conventional synchronization
acquisition processing is performed for a group/frame
other than database. In this processing, a combination
of groups/scramble codes targeted for database priority

25 processing has been already checked, detection is
judged to be unacceptable (NG). Thus, such combination
may be excluded from a candidate of spread codes.

Now, synchronization acquisition processing according to a third embodiment of the present invention will be described in detail with reference to FIG. 4.

5   Although the contents and flow of processing according to the third embodiment are identical to those according to the second embodiment, a configuration is made to adaptively change the number of database elements for making a check. For example, as

10   shown in FIG. 7, the use frequency of a group/code combination table is represented by a use rate (%), and only the tables indicating a rate equal to or greater than the use frequency specified in advance is targeted for search.

15   First, P-SCH inserted into each slot immediately after starting synchronization acquisition processing is detected, and a slot timing is identified (step S30). Next, a database table is checked prior to performing group identification processing, and the

20   number of elements in which the use frequency exceeds the specified threshold is obtained (step S31). For example, at this time, assuming that the threshold is 10%, three elements from No. 1 to No. 3 meet a condition in FIG. 7, and the number of checks is 3.

25   This value is defined as the set number, and the same processing as that according to the above described second embodiment is performed in accordance with the

steps S32 to S37, thereby enabling more efficient synchronization acquisition processing.

As has been described above, the past used groups or groups and scramble codes are stored in order based on use frequency. In the case where synchronization acquisition is performed, one or plural groups and scramble codes with high use frequency are searched with priority. In addition, in the case where a predetermined condition is met by groups and scramble codes that have been searched with priority, it is assumed that synchronization acquisition has completed, and the subsequent processing is not performed. In the case where the predetermined condition is not met, conventional search processing is performed for the other groups and codes. In this way, groups and scramble codes with high use frequency are first searched, thereby making it possible to remarkably reduce a time and an amount of synchronization acquisition processing.

The synchronization processing according to the above described embodiments may be performed by hardware.

According to the present invention, there can be provided a mobile radio apparatus and its control device capable of reducing an amount of synchronization acquisition processing and reducing a processing time and current consumption.

Additional advantages and modifications will
readily occur to those skilled in the art. Therefore,
the invention in its broader aspects is not limited to
the specific details and representative embodiments

5   shown and described herein. Accordingly, various
modifications may be made without departing from the
spirit or scope of the general inventive concept as
defined by the appended claims and their equivalents.